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Optimization Technique for Image Mosaicing using Local Visual Descriptor

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ABSTARCT:-

Since last few decades, in real time applications image mosaicing has been a challenging domain for image processing experts. In computer vision, Image mosaicing is one of the most important domain of research. The image mosaicing can be done using two different techniques. The first is the direct method and the second one is feature based method. Image Mosaicing technique is basically done into 5 phases, Which includes; feature extraction, registration, stitching, warping and blending. It has vast utilizations in the field of 3D image reconstruction, video conferencing, satellite imaging and several medical as well as computer vision fields. This paper presents the review of feature detection techniques for image mosaicing using image fusion. Initially, the input images are stitched together using the popular stitching algorithms i.e. Scale Invariant Feature Transform (SIFT) and Speeded-Up Robust Features(SURF). To extract the best features from the stitching results, the blending process is executed by means of Discrete Wavelet Transform (DWT) using the maximum selection rule for both approximate as well as detail-components.

Keywords- *Mosaicing, Direct, Feature, SIFT, SURF, DWT*

I. INTRODUCTION

A synthetic composition is generated from a sequence of images, is an image mosaic and it can be made by knowing the geometric relation between the images. The geometric relations are the coordinate system that relates the different image coordinate systems. By using the proper transformation via warping operation and binding the overlapping regions of warped images, The resultant image is the motivation for image mosaicing. Most techniques to image stitching require nearly accurate overlap between images and identical exposures to produce seamless results [1]. Image mosaicing plays a vital role in developing the panoramic view. The complementary information on individual image scenes in spatial and temporal domain can be binded to produce unsegmented panorama using images of smaller field of view. Virtual Environment and panoramic imaging has been an emerging field of research with the improved brain-computer interfacing to deal with real-time

applications. A number of images mosaicing algorithms have been proposed to create a seamless, vast view image to interpret real world more clearly. In this, a robust method for panoramic image mosaicing by means of image fusion. The proposed technique is consisting of two adeptive stitching algorithms i.e. SIFT and SURF. The SIFT algorithm implement better for images with scale and rotational variance. These properties are compensating the requirement of SURF. Again, the SURF is known for its better computational speed and illumination invariance. The response of both is blended together using the best image fusion rule. Here, the fusion process takes place using Haar Discrete Wavelet Transform (DWT). Image stitching algorithms divided into two types. The first is the direct method and the second one is features based method. The direct methods need an ambient initialization, whereas, feature based methods do not require initialization during registration [2]. The feature-based method primarily have four steps: feature detection, feature matching, transformation model estimation, image resampling and transformation

II. RELATED WORK

Image mosaicing is an important method in the computer vision field. Image mosaicing technique is being used in commercial software like Photoshop and algorithms are being enhanced one over another. Since long before the age of digital computers mosaicing and registration of images have been in practice. After the photographic process was developed in 1839, the use of photographs was described on topographical mapping. Images collected from balloons or hill-tops were manually pieced together. After the evolution of airplane technology (1903) aero photography became an exciting new field. The limited flying heights of the early airplanes and the demand for large photo-maps, forced imaging experts to construct mosaic images from overlapping photographs. This was initially done by manually mosaicing [3] images which were collected by

calibrated equipment. The demand for mosaicing continued to increase later in history as satellites started sending pictures back to earth. Growth in computer technology became a natural motivation to create computational techniques and to solve related problems. Several researchers have addressed different methods for obtaining the final image from its split parts. Schutte & Vossepoe (1995) and Szeliski (1996) have described the usage of flat bed scanners to capture large utility maps. Zappala et al (1997) and Peleg & Gee (1997) have worked on document image mosaicing (DIM). A feature-based approach through estimation of the motion from point correspondence is proposed. D. K. Jain et al., [4] proposed a three step automatic image mosaic method. In the first step, take two input images and find out the Harris corners [5] in both the images, second step is removing out the false corners in both the images and then by using homography, their matched corner pair are found and final output mosaic is obtained. D.G.Lowe proposed an algorithm called Scale Invariant Feature Transform (SIFT)[6], which is a technique to extract feature points. These features are from local scale-invariant features for object recognition, to recognise 3d objects and also for shape indexing using approximate nearest-neighbour search in high-dimensional spaces [7]. H.Bay et al., proposed a feature detector Speeded Up Robust Features (SURF) [8], which is believed to have high speed in the feature detection steps: detection, description and matching.

III. IMAGE MOSAICING TECHNIQUE

Image mosaic is a composed image produced from a sequence of images. Image Mosaicing technology [9] is becoming more and more popular in the fields of image processing, computer graphics, computer vision and multimedia. There are various steps in mosaicing like, feature extraction and registration, stitching and blending, wrapping. The image mosaicing can be done using two different techniques. The first is the direct method and the second one is feature based method. In direct method, each pixels are compared with each other so it's a very complex technique. The main advantage of direct technique is that it minimizes the sum of absolute differences

between overlapping pixels. They are not invariant to image rotation and scale.

In feature-based technique [10], all main feature points in an image pair is correlate with all features in the other image by using one of the local descriptors. The feature-based techniques are mainly used four steps: feature detection, feature matching, transformation model estimation, image resampling and transformation. Feature-based methods are used by establishing correspondences between points, lines, edges, corners or any other shapes. The main characteristics of robust detectors includes invariance to image noise, scale invariance, translation invariance, and rotation transformations. There are many feature detector techniques exist some of which are, Harris corner detector [5], Scale-Invariant Feature Transform (SIFT) [6], Speeded Up Robust Features (SURF) [8], Features from Accelerated Segment Test (FAST) [11], PCA-SIFT [12] and ORB [13] techniques. The main advantage of feature based technique is that it is more robust against any type of scene movement occurred in image. This method is very faster and it has the ability to recognise panoramas by automatically detecting the adjacency relationship between an ordered set of images. These qualities are best suited for fully automated stitching of panoramas. Feature based methods rely on accurate detection of image features. Correspondences between features lead to computation of the camera motion which can be tested for alignment. In the absence of distinctive features, this kind of approach is likely to fail.

The image mosaicing procedure generally includes three steps. First, we register input images by estimating the homography, which relates pixels in one frame to their corresponding pixels in another frame. Second, we warp input frames according to the estimated homographies so that their overlapping regions align. Finally, we paste the warped images and blend them on a common mosaicing surface to build the panorama result.

1. Harris Corner Detector

This operator was developed by Chris Harris and Mike Stephens in 1988 as a low-level processing step to help researchers trying to build interpretations of a robot's environment based on image sequences. Harris corner is based on local auto-correlation function of a signal where local auto-correlation function measures the local changes of the signal with patches shifted by a small amount in different directions. Harris corner are not scale-invariant.

Considering the gray intensity of pixel (u, v) be I(x, y), the variation of gray pixel (x , y)with a shift of (u, v) can be denoted as

$$E(u,v) = \sum_{x,y} w(x,y)[I(x+u,y+v) - I(x,y)]^2$$

(1)

With the application of Taylor series expansion

$$E(u,v) = \sum_{x,y} w(x,y)\left[I_x u + I_y v + O(u^2,v^2)\right]^2$$

(2)

For a small shift of (u, v) we have following approximation,

(3) $$E(u,v) \cong [u,v] M \begin{bmatrix} u \\ v \end{bmatrix}$$

Where M is a matrix of 2x2 which has been calculated from the image derivatives:

$$M = \sum_{x,y} w(x,y) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}$$

(4)

To extract the corner, Harris constructed the formula as below

$$R = \det(M) - k(tM)$$

(5)

det(M) is the determinant of M and tM is the trace of M, where k is the parameter greater than zero. The feature points that are the pixel value corresponding with the local maximum interest point, are taken into consideration with Harris method [5].

2. Scale invariant feature transform

Scale invariant feature transform algorithm[6] was proposed by Lowe in the year 1999. It has the unique features like affine transformation, rotation, noise immunity and scale invariance. In scale space, SIFT algorithm is based on feature spotting. The SIFT algorithm are based on four major parts: Scale space detection, preliminary confirm the key points, location and the scale. The middle point is compared with its 26 neighborhood points (8 points on the same plane and 18 points on planes lying above and below that point) to detect utmost points.The first stage used difference-of-Gaussian (DOG) function to identify potential interest points, which were invariant to scale and orientation. To improve the computation speed DOG was used instead of Gaussian DoG is represented using Equation

$$L(x,y,k\sigma) = F(x,y,k\sigma) \otimes I(x,y)$$ (6)

$$D(x,y,\sigma) = L(x,y,k_i\sigma) - L(x,y,k_j\sigma)$$ (7)

3. Speeded-Up Robust Features

SURF was firstly presented by Herbert Bay et al. in 2006, SURF (Speeded Up Robust Features)[8] is a robust local feature detector. It can be used in computer vision tasks like object recognition or 3D reconstruction. It is partly influenced by the SIFT descriptor. The standard version of SURF is several times faster than SIFT and more robust against different image transformations than SIFT. SURF is depend on the sum of 2D Haar wavelet responses and efficiently use the integral images. It uses an integer approximation to the determinant of Hessian blob detector, which can be calculated utterly quickly with an

integral image (3 integer operations). It uses the sum of the Haar wavelet response around the point of interest for features. Again, these can be calculated with the halp of the integral image.

IV. OUR APPROACH

The proposed method mainly contains the following steps:

i. image stitching Algorithms: These are defined above.

ii. image fusion: Image fusion is the process in which two or more images are blended together to create an image having all the common as well as complementary information from each of the original images. The blending process also generates a higher spatial resolution image free from all volatile blurring effects.

Pixel level image fusion techniques are mostly agitated by blurring effect and usually time consuming due to a large number of computations. So, in this, it is opted for wavelet base multi resolution analysis technique mitigating all issues due to pixel level fusion. The original image is passed through high pass and low pass filters so as to get the detail and approximate components. Again, the down sampling operation occurs followed by the next filtering stage to generate the low-low (LL), low-high (LH), high-low (HL), high-high (HH) image sub band components. Here, the Haar-wavelet implemented for the decomposition of better subjective analysis .

The unique features of Haar wavelet transform are its simplicity, excellent processing speed, reversibility as well as memory management. The Haar mother wavelet function can be presented as:

$$\psi(t) = \begin{cases} 1 & 0 \le t \le 0.5 \\ -1 & 0.5 \le t \le 1 \\ 0 & otherwise \end{cases} \qquad (9)$$

The scaling function $\phi(t)$ is given by

$$\emptyset(t) = \begin{cases} 1 & 0 \le t \le 0.5 \\ 0 & otherwise \end{cases} \qquad (10)$$

The lower order Haar matrix is

$$H_2 = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \qquad (11)$$

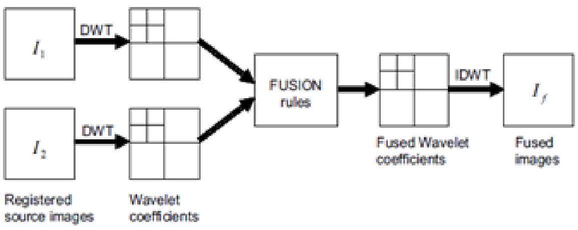

Fig:1 DWT based Image Fusion Flow chart

Fig 2 :Input Image-1

Fig 3:Input Image-2

Fig 4: SIFT Response

Fig 5: SURF Response

Fig 6: Fusion Responce

Both subjective as well as objective performance evaluation has been a crucial part of image quality evaluation process. Here, the simulation resultant image quality is verified in terms of PSNR, Feature Similarity Index (FSIM), Mutual Information (MI), Normalized Absolute Error(NAE) and Standard Deviation (SD).

V. EXPERIMENTS AND RESULTS

The experiment for the preferred technique was carried out using MATLAB 9.0 (R2016b) on a PC with the following configuration: Intel(R) Core(TM) i5-2430M CPU @ 2.40 GHz, 4GB RAM, 64 bit OS (Windows7).In the proposed technique, the two test images are acquired by means of a camera DSC-WS70, maximum aperture of 2.75, focal length of 14 mm and exposure time of 0.02 sec. The unique feature of the images is that, these are three dimensional rotational images. Here, the two captured images at rotational angle of 10º. The input images are shown in Fig.2 and Fig.3.

The images are processed through scale invariant feature transform and speeded-up robust features algorithms separately in a parallel process. The response of SIFT and SURF algorithms is shown in Fig.4 and Fig.5 respectively. The panoramic images generated from these algorithms are passed through the blending process using the Haar discrete wavelet transform. Here, implement the maximum-approximate and maximum-detail fusion rule to generate a panoramic image of high contrast, robust towards noise as well as illumination variation. The fused panoramic image is depicted in Fig.6. Here the panoramic image generated by the fusion process compensates the complementary features and boosts up the common features of individual stitching images. SURF algorithm has the distinctive property of illumination invariance along with good scale and rotation invariance property, whereas, SIFT is the most effective algorithm for scale and rotate image stitching [14]. But, it cannot cope up with illumination variation. Therefore, the resultant image proves superior as compared to the SIFT as well as SURF algorithms in terms of PSNR, Mutual Information (MI), Normalized Absolute Error (NAE), Feature Similarity Index Metric(FSIM), Standard Deviation (SD) and Measure of Enhancement (EME) showing in Table 1.

VI. CONCLUSION

The given work was based the implementation and the quantative evaluation of the three above mentioned image mosaicing techniques. Also an approach and methodology have been proposed to enhance the performance of the above methods to produce the best quality images by the fusion of the complimentary features specific to these algorithms. The test input images used for the present work were the planar 3-D images; it can be extended for the cylindrical and spherical images as well.

Algorithm/ Parameters	**SIFT**	**SURF**	**Proposed**
PSNR	41.693	41.962	42.416
FSIM	0.706	0.714	0.738
MI	1.209	1.264	1.470
EME	8.561	6.332	9.456
NAE	0.147	0.143	0.129
SD	56.846	56.542	57.283

Table 1: Comparison in Different Parameters

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